UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA, SAN FRANCISCO DIVISION

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| WAYMO LLC,<br>Plaintiff,<br>vs.<br>UBER TECHNOLOGIES, INC.; OTTOMOTTO LLC; OTTO TRUCKING LLC,<br>Defendants. | CASE NO. 3:17-cv-00939<br><br>**DECLARATION OF GREGORY KINTZ**<br><br>**REDACTED VERSION OF DOCUMENT FILED UNDER SEAL** |

I, Gregory Kintz, hereby declare as follows.

1. I have been asked by counsel for Waymo LLC ("Waymo") to provide an opinion as to whether Defendant Ottomotto LLC ("OttoMotto"), Defendant Otto Trucking LLC ("Otto Trucking), or Defendant Uber Technologies, Inc. ("Uber", and collectively, "Defendants"), through the accused LiDAR devices, infringe United States Patent Nos. 8,836,922 ("the '922 Patent") and 9,285,464 ("the '464 Patent) (collectively, "the Asserted Patents"). For this declaration I have limited my opinions to claims 1 and 13 of the '922 Patent and claims 1 and 14 of the '464 Patent. I have also been asked to provide an opinion on the validity of the Asserted Patents and on whether Waymo practices the Asserted Patents. I have also been asked to provide an opinion on Waymo's trade secrets incorporated into the accused LiDAR devices. My opinions are set forth below in this declaration.

2. The analysis and opinions contained in this declaration are based on the information currently available to me. I understand that the parties to this action have not yet taken formal discovery, and therefore there may be additional information produced by the parties that informs my opinions concerning the Patents. I reserve the right to supplement and amend my opinions after further discovery.

3. If I am called to testify as an expert witness, I expect to give testimony concerning my qualifications and experience, the technical subject matter of the Asserted Patents including infringement and validity, the accused LiDAR devices, Waymo's practice of the Asserted Patents, and on Waymo's trade secrets incorporated into the accused LiDAR devices.

4. I am being compensated for my work on this matter at my current standard rate of $200 per hour. I am separately reimbursed for expenses. As an independent consultant, I am being compensated solely for my time spent and my compensation is not contingent on the content of my opinions or the outcome of this litigation.

## I. QUALIFICATIONS AND EXPERIENCE

5. My qualifications for presenting the opinions in this declaration are set forth in my curriculum vitae, a copy of which is attached as Appendix A to this report.

6. I have more than 30 years of experience as a physicist working with laser optics. I am a member of the Optical Society for America, the International Society for Optics and Photonics (SPIE), and the Society for Information Display. I have been awarded 30 United States Patents and have seven applications pending in the fields of optics, displays, and lasers.

7. In 1983, I earned a B.S. in Physics with Highest Honor from the Georgia Institute of Technology in Atlanta, Georgia. In 1985, I earned a Masters of Science in Physics from the University of Colorado, Boulder. Since 1986, I have worked in the field of laser optics for numerous employers, including Lockheed Martin and the Naval Research Laboratory. My research and work has included the following subjects and projects: laser performance of diode-pumped, solid-state lasers; mounting and collimation of pulsed high-power laser diodes; development of high-power laser diodes, including mounting and collimation technologies; design of eye-safe lasers for coherent laser radar; analysis of single-mode fiberoptic receivers; testing and performance evaluation of a LiDAR system on a NASA 727 airplane; a laser and optical system used in texturing of hard disk drives; virtual panoramic display concepts; medical laser resonators; analysis of thermal lensing; a laser-marking application for agricultural seed production; and high-power laser fiber optical couplers.

8. Since 2005, I have worked as a Senior Consultant for Mount Mitchell Optics. My work at Mount Mitchell has spanned a variety of laser- and optical-related projects. Since that time I have also founded and worked for other companies including Laser Biopsy Inc., PROFUSA, and Auris Surgical Robotics. These roles spanned imaging technology, lens design, modeling of light propagation, and visualization systems for use by microrobots. At Auris Surgical Robotics I was named an Intellectual Property "All Star" in 2014 and 2015 for my contributions.

## II. MATERIALS CONSIDERED FOR THIS DECLARATION

9. In preparation of this declaration, I have considered materials cited herein, materials related to the Patents, the accused LiDAR system, and Waymo's LiDAR system, and also independent research on related issues.

10. With respect to the Patents, I have considered the Patents themselves and the prosecution histories.

11. With respect to the accused LiDAR device, I have considered technical documents and files inadvertently disclosed to Waymo that describe the design and layout of a printed circuit board ("[redacted] PCB") used in the system's transmit block, as well as the electrical components on the board. I have also reviewed an application from Defendants to Nevada Regulatory Authorities on September 15, 2016 (the "Nevada Application"), which describes Defendants' LiDAR implementation.

12. With respect to the Waymo LiDAR system, I have considered a drive comprising a copy of the approximately 14,000 files downloaded by Anthony Levandowski from Waymo's private SVN design server, as well as the Declaration of Pierre-Yves Droz filed concurrently herewith.

13. I have also reviewed various public materials relating to LiDAR technology. A list of materials I considered in preparing my declaration is attached as Appendix B.

## III. LEGAL STANDARDS

14. In this section I describe my understanding of certain legal standards. I have been informed of these legal standards by Waymo's attorneys. I am not an attorney, and I am relying only on instructions from Waymo's attorneys for these legal standards, which I apply in forming the opinions I set forth in this declaration.

15. ***Claim Construction***. I understand that claim construction is an issue of law for the Court to decide. I have been instructed by counsel that claim terms should be given their ordinary and customary meaning within the context of the patent in which the terms are used, i.e., the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention in light of what the patent teaches. Unless I expressly indicate otherwise, I will apply this ordinary and customary meaning to the terms of the claims throughout my analysis.

16. ***Infringement***. I understand that the patent specification includes the written description of one or more preferred embodiments of the invention, drawings, and figures. I understand that the patent claims define and measure the patent's scope. I understand that each claim defines a separate invention, and that a dependent claim incorporates each and every

element of the claim from which it depends. I understand that literal infringement occurs when the accused product includes each and every limitation of a given asserted claim, as that claim has been construed by the Court. I understand that a plaintiff must ultimately prove patent infringement by a preponderance of the evidence, meaning the accused device is more likely to infringe than not to infringe the asserted claim or claims.

17. ***Validity***. I understand that patent claims are presumed valid, and that an accused infringer bears the burden of proving invalidity by clear and convincing evidence. I understand that a patent is invalid as anticipated if a single prior art reference discloses every element of the claimed invention. I understand that a patent is invalid as obvious if the claimed differences between the subject matter of the patent and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains, and that it is improper to use hindsight to determine what would have been obvious at the time of the invention. I understand that a patent is invalid for lack of written description if the specification fails to describe the invention sufficiently to convey to a person of ordinary skill in the art that the patentee had possession of the claimed invention at the time of the filing of their application, and that a patent is invalid for lack of enablement if the specification fails to describe the manner and process of making and using the invention in a way that enables a person of skill in the art to make and use the full scope of the invention without undue experimentation.

18. ***Trade Secrets***. I understand that a trade secret is information that the owner has taken reasonable measures to keep secret, and that derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable through proper means by, the public another person who can obtain economic value from the disclosure or use of the information. I further understand that "misappropriation" within the trade secret context means the improper acquisition, use, or disclosure of a trade secret by an unauthorized person.

19. ***Person of Ordinary Skill in the Art***. I understand that many of the issues discussed above, including claim construction, infringement, and validity are analyzed from the perspective of a hypothetical person having ordinary skill in the art. The '922 Patent was filed on August 20, 2013. The '464 Patent was filed on August 18, 2015 as a continuation of the application that became the

’922 Patent. In my opinion, a person of ordinary skill in the art at the time of the invention would have had a Bachelor of Science degree in Physics, and at least three years’ experience in laser-based optical mapping systems, or the equivalent. I met and exceeded these qualifications at the time of the invention.

## IV. SUMMARY OF OPINIONS

20. Based on information currently available to me, it is my opinion that: (a) the accused LiDAR devices incorporate Waymo’s trade secrets; (b) the accused LiDAR devices infringe at least claims 1 and 13 of the ’922 Patent; (c) the ’922 Patent is valid; (d) Waymo’s LiDAR devices practice the ’922 Patent; (e) the accused LiDAR devices infringe at least claims 1 and 14 of the ’464 Patent; (f) the ’464 Patent is valid; and (g) Waymo’s LiDAR devices practice the ’464 Patent.

## V. OVERVIEW OF LIDAR

21. Light Detection And Ranging, known as LiDAR, uses light, often lasers, to map the surrounding environment by bouncing light waves off of objects in the surrounding environment. Specifically, the LiDAR system emits a light beam with a short high-power pulse of light, such as a laser beam. When the light beam makes contact with an object in the environment, the beam reflects off of that object and returns to the LiDAR device, where it is detected by the device. The LiDAR device can then measure the time and distance each light beam traveled. A longer round-trip time means a more distant object. Each round trip creates a “point” representing an object a given distance and direction from the emitting device. A LiDAR system rapidly emits an enormous number of beams, and feeds the data from each into imaging software to create a three-dimensional “point cloud.” With enough beams, this point cloud accurately depicts a high-resolution map of the surrounding environment.

22. Waymo’s first self-driving cars relied upon a third-party LiDAR system called the Velodyne HDL64. (Droz Decl. ¶ 17.) Eventually, Waymo developed a custom replacement for the HDL64 called the [redacted], which dramatically reduced size and cost. (*Id.*) Waymo patented certain key innovations of the [redacted], such as its use of a single transmit/receive lens, but the

patents did not disclose other information about the [redacted], such as its dimensions, materials used, and assembly processes. (Droz Decl. ¶ 16; *see* ’922 Patent, ’464 Patent.)

23. Waymo subsequently developed a next-generation device called the [redacted], and [redacted]. (Droz Decl. ¶¶ 10, 23.) Because these advances remain private and represent valuable innovations which give Waymo a competitive advantage in the self-driving vehicle space, these advancements reflect Waymo’s trade secrets.

## VI. <u>TRADE SECRET MISAPPROPRIATION</u>

### A. Summary of Trade Secret Opinions

24. I have reviewed Waymo’s Identification of Trade Secrets (the “TS List”).

25. I have reviewed a copy of the roughly 14,000 files downloaded from Google’s confidential design server by Anthony Levandowski. This download includes [redacted]

26. My trade secret opinion focuses on my review of the [redacted] PCB and the Nevada Application, and specifically on the trade secrets that appear to be incorporated into the accused LiDAR devices. These trade secrets relate to Waymo’s [redacted] LiDAR device, which uses transmit boards that include many features that are the same or substantially similar to features that Uber incorporated into the [redacted] PCB.

### B. Overview of Waymo’s [redacted] Trade Secrets

27. As discussed, Waymo’s [redacted] featured many innovative and useful concepts, some of which were patented and others of which Waymo maintained as trade secrets. I understand, however, that testing of the [redacted] revealed the need for further refinements. (Droz Decl. ¶ 20.) Specifically, I understand that based on test results, Waymo derived certain requirements which drove Waymo’s development of its next-generation model, the [redacted]. (Droz Decl. ¶ 22; TS List Nos. 21-30.) The development of these requirements, the requirements themselves, the concepts

Waymo pioneered to meet these requirements, and many features of the completed [redacted], are all valuable trade secrets. (Droz Decl. ¶¶ 17-22.)

**C. Trade Secrets Resulting from the Testing of [redacted] and Development of [redacted]**

28. During its testing of [redacted], Waymo discovered specific use cases for which the device gave suboptimal performance. For example, I understand that [redacted]. (Droz Decl. ¶ 21.) This testing led Waymo to improve its resolution to solve for these use cases. (*Id.* ¶ 22.) In the following sections, I describe specific design features of [redacted] that Waymo developed in order to improve its system.

[redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[1] For visual comparison purposes, the above is the mirror image of the [redacted] PCB assembly drawing.

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

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[redacted]

[redacted]

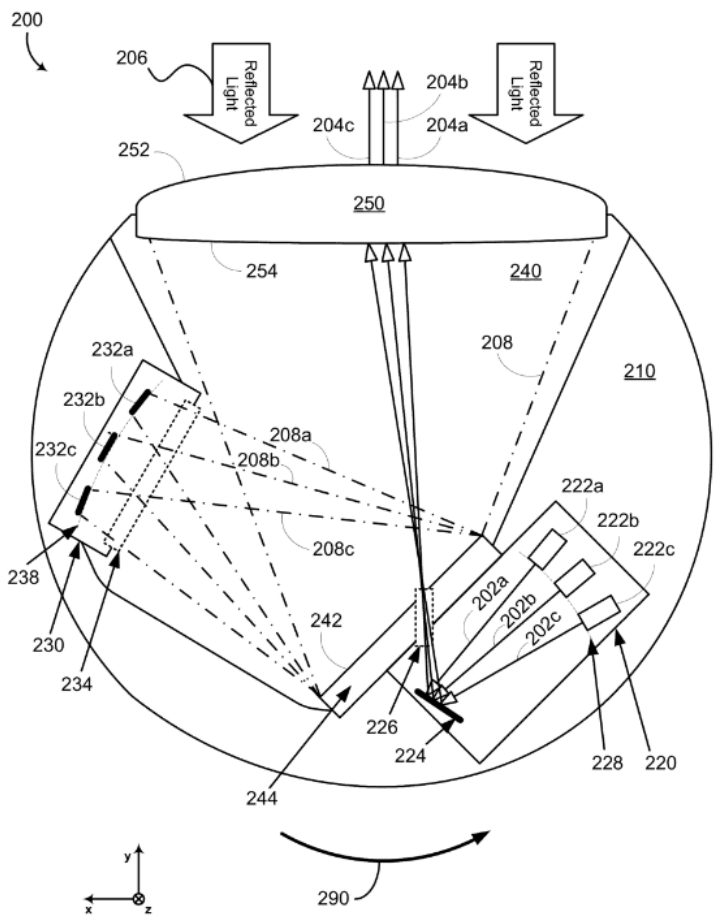
[redacted]

[redacted]

## VII. THE '922 PATENT

### A. Description and Background of the '922 Patent

56. The '922 Patent teaches an elegant and compact LiDAR configuration that offers advantages in size, cost, and complexity compared to prior LiDAR configurations. The key innovation over prior art is use of a common lens to both transmit and receive light beams, rather than separate lenses for transmission and receipt. ('922 Patent at 4:5-11.) According to the patent, the lens is mounted to a housing. (*Id.* at 1:50-51.) Within the housing, a transmit block emits light to the lens via an exit aperture in a wall that includes a reflective surface. (*Id.* at 3:61-67, 4:37-39.) When that light returns after reflecting off of an object in the surrounding environment, the lens focuses that light on photoreceptors within a receive block via the same reflective surface that contains the exit aperture. (*Id.* at 4:26-39.) Figure 2 illustrates this configuration:




**’922 Patent, Figure 2**

## B. Prosecution History

57. The ’922 file history is attached as Exhibit A. The application underlying the ’922 Patent was filed on August 20, 2013. In a non-final rejection dated February 13, 2014, the Examiner rejected the claims as unpatentable over certain combinations of prior art references. In response, without conceding to the rejection, the Applicant amended certain claims and cancelled others. In an interview with the Applicant, the Examiner agreed that the claim amendments overcame the prior rejections, but stated that she wished to consider a further reference, to Carloff (U.S. Patent No. 7,259,838). The Examiner then allowed the claims. In her statement of reasons for allowance, the Examiner stated that “[n]o combination of the closest prior art teaches or suggests the limitations of claims 1 and 17.”

## C. Asserted Claims

58. Claim 1 of the ’922 Patent claims:

A light detection and ranging (LiDAR) device, comprising:

a lens mounted to a housing, wherein the housing is configured to rotate about an axis and has an interior space that includes a transmit block, a receive block, a transmit path, and a receive path, wherein the transmit block has an exit aperture in a wall that comprises a reflective surface, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein the receive path extends from the lens to the entrance aperture via the reflective surface;

a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range;

a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and

wherein the lens is configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LiDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LiDAR device, and focus the collected light onto the detectors via the receive path.

59. Claim 13 of the ’922 Patent claims:

The LiDAR device of claim 1, wherein each light source in the plurality of light sources comprises a respective laser diode.

**D. Infringement of the ’922 Patent**

60. I understand the ’922 Patent has not been previously asserted in litigation, and that no court or other adjudicator has previously construed its claims. I reserve the right to consider any future claim construction orders that relate to my opinions. As explained above, my opinions are currently based on the claims as I believe a person of ordinary skill in the art would have understood them at the relevant time. I will now explain my opinions regarding infringement of each element of the asserted claims.

61. It is my opinion that the accused LiDAR devices infringe at least claims 1 and 13 of the ’922 Patent, as set forth below:

(a) <u>Infringement of Claim 1 of the ’922 Patent</u>

(i) **A light detection and ranging (LiDAR) device, comprising:**

62. The accused LiDAR device is a light detection and ranging (LiDAR) device. Defendants admit in the Nevada Application that "Otto's product is a suite of technology hardware and software, including cameras, radar, LiDAR. . . .," and that its currently-employed technology includes "**LiDAR –** In-house custom built 64-laser (Class 1) emitting 6.4 million beams a second at 10Hz."

(ii) **a lens mounted to a housing, wherein the housing is configured to rotate about an axis and has an interior space that includes a transmit block, a receive block, a transmit path, and a receive path, wherein the transmit block has an exit aperture in a wall that comprises a reflective surface, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein the receive path extends from the lens to the entrance aperture via the reflective surface;**

63. The first part of this claim element describes a lens mounted to a housing, wherein the housing is configured to rotate about an axis. The accused LiDAR device meets this limitation. The accused LiDAR device is used for self-driving technology, which requires that the vehicle map its surrounding environment. Thus, the accused LiDAR devices would feature a lens mounted to a housing that rotates around an axis to map a 360-degree view of the environment surrounding the vehicle upon which the LiDAR device is mounted. Other configurations, such as a rotating mirror outside the lens, would not provide the broad field of view required for a self-driving vehicle.

64. The second part of this claim element describes the interior space of the housing to which the lens is mounted, namely, that the space includes a transmit block, a receive block, a transmit path, and a receive path, wherein the transmit block has an exit aperture in a wall that comprises a reflective surface, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein the receive path extends from the lens to the entrance aperture via the reflective surface. As detailed below, the accused LiDAR device uses the configuration described by this claim limitation. Specifically, the accused LiDAR device emits light from a transmit block to the lens via a narrow exit aperture within a wall with a

mirrored surface (transmit path), and that light returns through the same lens to the receive block via the same mirrored surface (receive path).

65. Generally speaking, this limitation describes that the same common lens be used both to transmit laser-emitted beams into the environment and to collect and focus returning object-reflected beams. [redacted]

[redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted], using a single lens guarantees that light emitted by a given diode will return focused onto its corresponding photoreceptor. It would be extremely difficult to achieve this symmetry using separate transmit and receive lenses, because it is difficult to manufacture two lenses that are exactly alike, and because in such a system one or both lenses would require recalibration to ensure that the curvature and positioning of the lenses directs each of the 64 outgoing beams to their respective receptors.

[redacted]:

[redacted]

74. Accordingly, in my opinion, for at least the two reasons described above, the accused LiDAR device is a common lens design as claimed in the '922 and this limitation in particular. The device includes a transmit block, [redacted] and a transmit path defined between the transmit block and the common lens. The device also includes a receive block [redacted], and a receive path defined between the common lens and the receive block.

75. ***wherein the transmit block has an exit aperture in a wall that comprises a reflective surface, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein the receive path extends from the lens to the entrance aperture via the reflective surface***. This portion of the limitation further describes the optical configuration that enables the common-lens design, specifically the relative placement of the transmit and receive blocks with respect to the exit aperture in the claimed common lens design. Generally speaking, this portion of the limitation describes (1) the transmit

path: that light traveling from the laser diodes must travel through an exit aperture in a wall that comprises a reflective surface on its way to the lens; and (2) the receive path: that object-reflected light enters through the lens, bounces off the reflective surface of the wall that contains the exit aperture, then travels to the entrance aperture fronting the receive block. These claim limitations are also consistent with and suggested by the [redacted] PCB board.

76. As established above, the features of the [redacted] PCB board are consistent with and suggest a single common lens design. In such a configuration, the narrow exit aperture likely sits within a wall because that placement avoids an interference problem otherwise present. In a common-lens system, the transmit block and receive block are necessarily in the same interior housing space because the light must travel from the transmit block to the lens and also return from the lens to the receive block. This creates the potential for interference, i.e., that light emitted by the transmit block will be inadvertently detected by the receive block (which should capture only light that is returning from the outside environment). Shielding the lasers behind a wall prevents this interference, but the wall must contain a small exit aperture so that light can escape to the lens and enable the LiDAR device to function. A very narrow exit aperture in a shielding wall, through which outgoing beams each pass, allows the LiDAR device to emit full light while effectively (if not completely) mitigating the interference problem.

77. While the side of the wall facing the transmit block acts to shield the lasers from interfering with the receive block, the other side of the wall comprises a reflective surface. This is because in a common-lens system, the transmitted beams and the returning beams share a path. Because light along the transmit path travels from the exit aperture to the lens (as detailed above), returning object-reflected light travels from the lens to the exit aperture. The light should not travel back through the exit aperture, however, because such light would hit the transmit block rather than the receive block. Instead, the side of the wall that faces the returning object-reflected light is reflective, and serves to direct the returning light towards the receive block. Further, the wall's mirror function is also consistent with the narrow exit aperture enabled by the large pre-collimating lens. Any collected light that returns and hits the exit aperture, rather than the mirror, will be "lost" instead of directed towards the receive block. A narrow aperture minimizes this loss

and ensures that most of the collected light will make it to the receive block. Thus, the narrowness of the exit aperture serves two purposes: to allow the shield-side of the wall to contain all but the few photons that escape through the aperture, and to allow the mirror-side of the wall to reflect all but a few photons towards the receive block.

78. Further, the returning light likely passes through an entrance aperture on its way to the photodetectors because it is typical in LiDAR systems to use an entrance aperture to minimize the aberrations of the returning light. Because lenses are imperfect, any given lens will fail in some instances to properly focus light beams onto the detectors. Optical systems therefore use an entrance aperture to block this aberrant light from reaching the detectors.

(iii) **a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range;**

79. The accused LiDAR devices include a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range.

80. Defendants disclosed to Nevada authorities that the accused LiDAR devices comprise 64 total lasers firing 6.4 million beams per second, and the [redacted] PCB, [redacted]

[redacted] [redacted]

82. The light beams comprise light having wavelengths in a wavelength range because [redacted].

(iv) **a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and**

83. The accused LiDAR devices include a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range.

84. As discussed above, the accused LiDAR devices use a plurality of light sources in the transmit block. Therefore, the accused LiDAR devices in all likelihood use a plurality of detectors in the receive block. While it is theoretically possible to "share" a single detector among a plurality of lasers, to do so requires firing only one laser at a time to eliminate ambiguity as to which laser is responsible for a given return beam. Because the accused LiDAR device uses 64 lasers to emit 6.4 million beams a second, however, it is highly probable that it fires lasers simultaneously. If the lasers fired serially, each laser would have to wait long enough to eliminate ambiguity, and as a result it would take more than one second to emit 6.4 million beams. Even assuming a frequent uniform pulse rate of 250 nanoseconds in the accused LiDAR devices (which would limit the device range to less than 125 feet), it would take 1.6 seconds to fire 6.4 million beams [(250*6,400,000) / 1,000,000,000 = 1.6].

85. The detectors are configured to detect light having wavelengths in the same wavelength range emitted by the light sources. The fundamental concept of a LiDAR device is to emit light and then detect that light upon its return after being reflected by an object in the outside environment. It would not make sense to design a LiDAR device incapable of detecting the reflected light.

(v) **wherein the lens is configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LiDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects**

**in the environment of the LiDAR device, and focus the collected light onto the detectors via the receive path.**

86. The accused LiDAR devices include a lens configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LiDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LiDAR device, and focus the collected light onto the detectors via the receive path.

87. As explained above, the accused LiDAR device uses a shared lens to receive light via the transmit path for transmission into the environment and to collect and focus returning light onto the receive block via the receive path. Further, virtually all transmitting lenses in LiDAR systems collimate light for transmission into the surrounding environment, and virtually all receiving lenses in LiDAR systems focus the collected light onto the detectors.

(b) Infringement of Claim 13 of the ’922 Patent

(i) **The LiDAR device of claim 1, wherein each light source in the plurality of light sources comprises a respective laser diode.**

88. The accused LiDAR device meets all the elements of Claim 1, as explained above.

89. Further, the [redacted] PCB features [redacted]

**E. Validity of the ’922 Patent**

90. It is my opinion that claims 1 and 13 of the ’922 Patent are valid.

91. In reaching this opinion, I have considered the claims, specification, and prosecution history of the patent, including the prior art references identified by the USPTO as grounds for initial rejection of the claims, and I have relied on my knowledge of and expertise regarding LiDAR. I have also relied on the legal standards regarding validity discussed above.

92. In my experience, I have seen, used, and read about a wide variety of LiDAR systems. To the best of my recollection, however, I have not seen any disclosures or actual devices that meet the elements of the claims of the ’922 Patent, including claims 1 and 13, and that also pre-date the August 20, 2013 priority date. My experience thus supports my opinion that the

invention of the ’922 Patent was novel, and not anticipated by any device or publication in the prior art.

93. Further, the configuration of the ’922 Patent was a departure from the LiDAR devices in existence at the time. The invention made advances in size, cost, and complexity, and would not have been obvious to a person of ordinary skill in the art. There are LiDAR systems in the prior art, but none achieve the benefits enabled by the elegant configuration disclosed by the ’922 Patent. Waymo’s invention was unique.

**F. Waymo’s Use of the Patented ’922 Technology**

94. I understand that Waymo’s products incorporate the claimed features of the ’922 Patent. I have reviewed internal Waymo documentation describing Waymo’s [redacted] device, including a photo of the device and a ray-trace diagram illustrating that Waymo practices the ’922 Patent.

[redacted]

95. I have also discussed with Waymo LiDAR engineer Pierre-Yves Droz, who confirmed my understanding of the Waymo’s current products and how they practice at least claim 1 of the ’922 Patent. Specifically, Waymo’s devices feature a lens mounted to a housing which rotates about a vertical axis and may be mounted on top of an autonomous vehicle. The housing

contains both a transmit block with a plurality of receptors and a receive block with a corresponding plurality of detectors. The light sources in the transmit block travel to the lens (transmit path) in the same space through which the returning object-reflected light travels from the lens to the receive block, and along the transmit path, the outgoing light travels through an exit aperture in a wall comprising a reflective surface. (Conversation with P. Droz.)

96. Thus, Waymo's products practice the '922 Patent.

## VIII. THE '464 PATENT

### A. Description and Background of the '464 Patent

97. The '464 Patent is a continuation of the '922 Patent, and shares its specification and figures. I incorporate by reference my discussion on the description and background of the '922 Patent.

### B. Prosecution History

98. The '464 file history is attached as Exhibit B. The application underlying the '464 Patent was filed on August 14, 2014. In a non-final rejection dated June 17, 2015, the Examiner rejected certain claims for nonstatutory double patenting over the '922 Patent and as unpatentable as obvious over a number of prior art combinations. In response, the Applicant filed a terminal disclaimer to obviate the double patenting rejection. Without conceding to the rejection, the Applicant amended both independent claims to distinguish over the prior art, and cancelled a dependent claim. The Examiner agreed that the amendments overcame the prior art, but stated that she would conduct a further prior art search before allowing the claims. The Examiner then allowed the claims. In her statement of reasons for allowance, the Examiner noted that "there would be no motivation to combine the prior art references to achieve[] the claimed system without unreasonable hindsight," and further added that the claimed invention is "compact, low maintenance and minimally complex."

### C. Asserted Claims

99. Claim 1 of the '464 Patent claims:

A light detection and ranging (LiDAR) device, comprising:

a lens mounted to a housing, wherein the housing is configured to rotate about an axis and has an interior space that includes a transmit block, a receive block, a transmit path, and a receive path, wherein the transmit block has an exit aperture, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, wherein the receive path extends from the lens to the entrance aperture, and wherein the transmit path at least partially overlaps the receive path in the interior space between the transmit block and the receive block;

a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range;

a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and

wherein the lens is configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LiDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LiDAR device, and focus the collected light onto the detectors via the receive path.

100. Claim 14 of the ’464 Patent claims:

The LiDAR device of claim 1, wherein each light source in the plurality of light sources comprises a respective laser diode.

**D. Infringement of the ’464 Patent**

101. I understand the ’464 Patent has not been previously asserted in litigation, and that no court or other adjudicator has previously construed its claims. I reserve the right to consider any future claim construction orders that relate to my opinions. My opinions are currently based on the claims as I believe a person of ordinary skill in the art would have understood them. I will now explain my opinions regarding infringement of each element of the exemplary asserted claims.

102. It is my opinion that the accused LiDAR devices infringe claims 1 and 14 of the ’464 Patent, as set forth below:

(a) <u>Infringement of Claim 1 of the ’464 Patent</u>

(i) **A light detection and ranging (LiDAR) device, comprising:**

103. The accused LiDAR device is a light detection and ranging (LiDAR) device. Defendants admit in the Nevada Application that “Otto’s product is a suite of technology hardware

and software, including cameras, radar, LiDAR. . . .," and that its currently-employed technology includes "**LiDAR –** In-house custom built 64-laser (Class 1) emitting 6.4 million beams a second at 10Hz."

(ii) **a lens mounted to a housing, wherein the housing is configured to rotate about an axis and has an interior space that includes a transmit block, a receive block, a transmit path, and a receive path, wherein the transmit block has an exit aperture, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, wherein the receive path extends from the lens to the entrance aperture, and wherein the transmit path at least partially overlaps the receive path in the interior space between the transmit block and the receive block;**

104. The first part of this claim element describes a lens mounted to a housing, wherein the housing is configured to rotate about an axis. The accused LiDAR device meets this limitation. The accused LiDAR device is used for self-driving technology, which requires that the vehicle map its surrounding environment. Thus, the accused LiDAR devices would feature a lens mounted to a housing that rotates around an axis to map a 360-degree view of the environment surrounding the vehicle upon which the LiDAR device is mounted. Other configurations, such as a rotating mirror outside the lens, would not provide the broad field of view required for a self-driving vehicle.

105. The second part of this claim element describes the interior space of the housing to which the lens is mounted, namely, that the space includes a transmit block, a receive block, a transmit path, and a receive path, wherein the transmit block has an exit aperture, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, wherein the receive path extends from the lens to the entrance aperture, and wherein the transmit path at least partially overlaps the receive path in the interior space between the transmit block and the receive block. As detailed below, the accused LiDAR device uses the configuration described by this claim limitation. Specifically, the accused LiDAR device emits light from a transmit block to the lens via a narrow exit aperture within a wall with a mirrored surface (transmit

path), and that light returns through the same lens to the receive block via the same mirrored surface (receive path); thus, the transmit path partially overlaps the receive path.

106. Generally speaking, this limitation describes that the same common lens be used both to transmit laser-emitted beams into the environment and to collect and focus returning object-reflected beams. [redacted]

[redacted]

[redacted]

[redacted]

[redacted] using a single lens guarantees that light emitted by a given diode will return focused onto its corresponding photoreceptor. It would be extremely difficult to achieve this symmetry using separate transmit and receive lenses, because it is difficult to manufacture two lenses that are exactly alike, and because in such a system one or both lenses would require recalibration to ensure that the curvature and positioning of the lenses directs each of the 64 outgoing beams to their respective receptors.

[redacted]

[redacted]

115. Accordingly, in my opinion, for at least the two reasons described above, the accused LiDAR device is a common lens design as claimed in the ’464 and this limitation in particular. The device includes a transmit block, [redacted], and a transmit path defined between the transmit block and the common lens. The device also includes a receive block [redacted] and a receive path defined between the common lens and the receive block.

116. ***wherein the transmit block has an exit aperture, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, wherein the receive path extends from the lens to the entrance aperture, and wherein the transmit path at least partially overlaps the receive path in the interior space between the transmit block and the receive block***. This portion of the limitation further describes the optical configuration that enables the common-lens design. Generally speaking, this portion of the limitation describes (1) the transmit path: that light traveling from the laser diodes must travel through an exit aperture to

the lens; (2) the receive path: that object-reflected light travels from the lens to the receive block; and (3) that the transmit path at least partially overlaps the receive path in the interior space between the transmit block and the receive block. These claim limitations are also consistent with and suggested by the [redacted] PCB board.

117. As established above, the features of the [redacted] PBC board are consistent with and suggest a single common lens design. In such a configuration, the narrow exit aperture likely sits within a wall because that placement avoids an interference problem otherwise present. In a common-lens system, the transmit block and receive block are necessarily in the same interior housing space because the light must travel from the transmit block to the lens and also return from the lens to the receive block. This creates the potential for interference, i.e., that light emitted by the transmit block will be inadvertently detected by the receive block (which should capture only light that is returning from the outside environment). Shielding the lasers behind a wall prevents this interference, but the wall must contain a small exit aperture so that light can escape to the lens and enable the LiDAR device to function. A very narrow exit aperture in a shielding wall, through which outgoing beams each pass, allows the LiDAR device to emit full light while effectively (if not completely) mitigating the interference problem.

118. While the side of the wall facing the transmit block acts to shield the lasers from interfering with the receive block, the other side of the wall comprises a reflective surface. This is because in a common-lens system, the transmitted beams and the returning beams share a path, that is to say, overlap. Because light along the transmit path travels from the exit aperture to the lens (as detailed above), returning object-reflected light travels from the lens to the exit aperture. The light should not travel back through the exit aperture, however, because such light would hit the transmit block rather than the receive block. Instead, the side of the wall that faces the returning object-reflected light is reflective, and serves to direct the returning light towards the receive block. Further, the wall's mirror function is also consistent with the narrow exit aperture enabled by the large pre-collimating lens. Any collected light that returns and hits the exit aperture, rather than the mirror, will be "lost" instead of directed towards the receive block. A narrow aperture minimizes this loss and ensures that most of the collected light will make it to the

receive block. Thus, the narrowness of the exit aperture serves two purposes: to allow the shield-side of the wall to contain all but the few photons that escape through the aperture, and to allow the mirror-side of the wall to reflect all but a few photons towards the receive block. Furthermore, any receive-path beam that bounces off the mirror on the opposite side of the exit aperture from the receive block will necessarily overlap its own transmit path on the way to the receive block.

119. Further, the returning light likely passes through an entrance aperture on its way to the photodetectors because it is typical in LiDAR systems to use an entrance aperture to minimize the aberrations of the returning light. Because lenses are imperfect, any given lens will fail in some instances to properly focus light beams onto the detectors. Optical systems therefore use an entrance aperture to block this aberrant light from reaching the detectors.

(iii) **a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range;**

120. The accused LiDAR devices include a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range.

121. Defendants disclosed to Nevada authorities that the accused LiDAR devices comprise 64 total lasers firing 6.4 million beams per second, and the [redacted] PCB, [redacted]

[redacted] [redacted]

123. The light beams comprise light having wavelengths in a wavelength range because [redacted]

(iv) **a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and**

124. The accused LiDAR devices include a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range.

125. As discussed above, the accused LiDAR devices use a plurality of light sources in the transmit block. Therefore, the accused LiDAR devices in all likelihood use a plurality of detectors in the receive block. While it is theoretically possible to "share" a single detector among a plurality of lasers, to do so requires firing only one laser at a time to eliminate ambiguity as to which laser is responsible for a given return beam. Because the accused LiDAR device uses 64 lasers to emit 6.4 million beams a second, however, it is highly probable that it fires lasers simultaneously. If the lasers fired serially, each laser would have to wait long enough to eliminate ambiguity, and as a result it would take more than one second to emit 6.4 million beams. Even assuming a frequent uniform pulse rate of 250 nanoseconds in the accused LiDAR devices (which would limit the device range to less than 125 feet), it would take 1.6 seconds to fire 6.4 million beams [(250*6,400,000) / 1,000,000,000 = 1.6].

126. The detectors are configured to detect light having wavelengths in the same wavelength range emitted by the light sources. The fundamental concept of a LiDAR device is to emit light and then detect that light upon its return after being reflected by an object in the outside environment. It would not make sense to design a LiDAR device incapable of detecting the reflected light.

(v) **wherein the lens is configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LiDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects**

**in the environment of the LiDAR device, and focus the collected light onto the detectors via the receive path.**

127. The accused LiDAR devices include a lens configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LiDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LiDAR device, and focus the collected light onto the detectors via the receive path.

128. As explained above, the accused LiDAR device uses a shared lens to receive light via the transmit path for transmission into the environment and to collect and focus returning light onto the receive block via the receive path. Further, virtually all transmitting lenses in LiDAR systems collimate light for transmission into the surrounding environment, and virtually all receiving lenses in LiDAR systems focus the collected light onto the detectors.

(b) Infringement of Claim 14 of the ’464 Patent

(i) **The LiDAR device of claim 1, wherein each light source in the plurality of light sources comprises a respective laser diode.**

129. The accused LiDAR device meets all the elements of Claim 1, as explained above.

130. Further, the [redacted] PCB features [redacted]

**E. Validity of the ’464 Patent**

131. It is my opinion that claims 1 and 14 of the ’464 Patent are valid.

132. In reaching this opinion, I have considered the claims, specification, and prosecution history of the patent, including the prior art references identified by the USPTO as grounds for initial rejection of the claims, and I have relied on my knowledge of and expertise regarding LiDAR. I have also relied on the legal standards regarding validity discussed above.

133. In my experience, I have seen, used, and read about a wide variety of LiDAR systems. To the best of my recollection, however, I have not seen any disclosures or actual devices that meet the elements of the claims of the ’464 Patent, including claims 1 and 14, and that also pre-date the August 20, 2013 priority date. My experience thus supports my opinion that the

invention of the ’464 Patent was novel, and not anticipated by any device or publication in the prior art.

134. Further, the configuration of the ’464 Patent, mounting a single lens to a housing containing both a transmit block with a plurality of lasers and a receive block with a plurality of detectors, and with the transmit path including an exit aperture, a receive path including an entrance aperture, and wherein the transmit path at least partially overlaps the receive path in the interior space between the transmit block and the receive block, was a departure from the LiDAR devices in existence at the time. The invention made advances in size, cost, and complexity, and would not have been obvious to a person of ordinary skill in the art. There are LiDAR systems in prior art, but none achieve the benefits enabled by the elegant configuration disclosed by the ’464 Patent. Waymo’s invention was unique.

**F. Waymo’s Use of the Patented ’464 Technology**

135. I understand that Waymo’s products incorporate the claimed features of the ’464 Patent. I have reviewed internal Waymo documentation describing Waymo’s [redacted] device, including a photo of the device and a ray-trace diagram illustrating that Waymo practices the ’464 Patent.

[redacted]

136. I have also discussed with Waymo LiDAR engineer Pierre-Yves Droz, who confirmed my understanding of the Waymo's current products and how they practice at least claim 1 of the '464 Patent. Specifically, Waymo's devices feature a lens mounted to a housing which rotates about a vertical axis and may be mounted on top of an autonomous vehicle. The housing contains both a transmit block with a plurality of receptors and a receive block with a corresponding plurality of detectors. The light sources in the transmit block travel to the lens (transmit path) in the same space through which the returning object-reflected light travels from the lens to the receive block, and the transmit path at least partially overlaps the receive path. (Conversation with P. Droz.)

137. Thus, Waymo's products practice the '464 Patent.

I declare under penalty of perjury that the foregoing is true and correct.

DATED: March 10, 2017

Gregory Kintz